BALLAST DEVICE WITH BUILT-IN POWER SUPPLY AND OPERATION METHOD THEREOF

TECHNICAL FIELD

The present invention relates to a ballast device and an operation method of the ballast device, and especially to a ballast device having a built-in a power supply unit and a micro control unit based circuit.

DESCRIPTION OF RELATED ARTS

Presently, most light sources for projectors are HID (High Intensity Discharge) device. To avoid damaging caused by an unsteady power source or an improper manipulation, the projector must have a steady power control device. The existent power control device 1' of a HID lamp as shown in Fig.1, comprises a power supply 10' and a ballast 20'. The power supply 10' and the ballast 20' are set, respectively, in assistant power circuits 115' and 220' separate from each other.

The operational mode of the existent power control device 1' of a HID lamp as shown in Fig.1 is as follows: firstly, said power supply 10' is activated to receive an input electrical source (AC95V~230V) 100'. Then an EMI (Electro Magnetic Interference) Filter 105' built in said power supply 10' wipes off EMI. A PFC (Power Factor Correction) 110' transforms the AC input electrical source 100' into DC and divides it into two routes, and one of them inputs into the ballast 20', and is stepped down by a DC-DC transformer 200', and then converted into practical working voltage by a DC-AC transformer 205' to supply to the HID lamp 30'.

But what should be noticed is the ballast mode of said ballast 20'; it passively detects the lamp's practical current, and then controlling the current via the transfer function of a PWM (Pulse-Width Modulation) 215'. Further, circuit of the existing

ballast is more complex due to an extra assistant power circuit 220' is needed for supplying a working voltage to the ballast 20'. Moreover, because the ballast 20' passively detects the lamp's practical current, it can't steadily control the power in a real time manner.

SUMMARY OF THE INVENTION

A main object of the present invention is to provide a ballast device having active ballasting circuit and method thereof, make a power supply embedded into a ballast, so the ballast's working power can be supplied by the power supply unit directly, and then incorporate the formerly two power circuits into one without adding any assistant power circuits like existing technology, so it can save cost and predigest the whole ballast system.

A subordinate object of the present invention is to provide a ballast device having active ballasting circuit and method thereof. It actively detects and ballasts the lamp's practical current by a MCU (Micro Control Unit) and thereby controls a HID lamp's start-up process steadily and real-timely.

Another subordinate object of the present invention is to provide a ballast device having active ballasting circuit and method thereof. It detects the working status of the ballast or the HID lamp via a MCU as its referring outer parameters and real-timely transforms the practical active current of the HID lamp.

In accordance with the present invention, said active ballasting device, which is used to steadily control a load module (such as a HID lamp)'s control power, comprising: a power supply unit, a micro control unit, some detection modules and a PWM control unit.

The power supply unit is used to receive an electrical source, comprising: an

EMI Filter for filtering EMI in the electrical source, a DC-DC transformer for stepping down the voltage that inputted into the DC-DC transformer, a PFC for transiting said filter AC to DC and outputting to said assistant power circuit and said DC-DC transformer respectively, and a DC-AC transformer.

Some detection modules are used to detect the working status of the ballast (except for the micro control unit) and/or the HID lamp as outer parameters for said MCU's reference. The MCU uses said outer working voltage directly, and generates said predefined load current according to said outer parameters.

The PWM control unit, which uses a PID control module to calculate said predefined load current and the load module's practical load current, and makes said DC-DC transformer change it's output voltage according to the calculate result, thereby transforms the load module's practical load current real-timely and steadily.

Besides above, an active ballasting method according to the present invention for steadily controlling a ballast device and the practical load current of the load module such as a HID lamp, comprises: activating power supply unit to receive an electrical source and generating outer working voltage by an assistant power circuit; stepping down the voltage that inputted into a DC-DC transformer by a power supply unit's DC-DC transformer; detecting the working status of the ballast device or the HID lamp as outer parameters for a MCU's reference; fetching said outer parameters to generate a predefined load current by the MCU which using said outer working voltage, and further judging whether the outer parameters are in the MCU's predefined range to determine to give an information that can be distinguished by user or not; calculating said predefined load current and said practical load current by a PID control module; and making said transformer change it's output voltage by the result of calculation; and then changing the load module's practical load active current steadily and real-timely.

The present invention has a simple structure, can save cost and simplify the whole system. The present invention also can change the practical load current steadily and real-timely.

Other objects, advantages and novel features of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sketch map of an existing HID lamp projector's power control device.

Fig. 2 is a sketch map of a ballast device according to the present invention's preferred embodiment.

Fig.3 is a working flow chart of a ballast device's MCU according to the present invention's preferred embodiment.

Fig .4 is a flow chart of a ballast device steadily controlling a HID lamp's practical load current according to the present invention's preferred embodiment.

Fig.5 is an active characteristic graph of a HID lamp according to the present invention's preferred embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Referring to Fig. 2, a ballast device 1 according to the present invention's preferred embodiment for steadily controlling a load module's (e.g. a HID lamp 20) control power, comprises a power supply unit 10, a MCU 100, some detection modules (not shown) and a PWM control unit.

Said power supply unit 10 receives an electrical source 200 when the power

switch is activated, said power supply unit 10 comprising: an EMI Filter 202 for filtering EMI, an assistant power circuit 235 for generating an outer working voltage V_{dd} as the working power of the MCU 100 and for generating an interior working voltage V_{cc} as the power supply of the rest units, a PFC 204 for transforming the AC power sent by the filter 202 to DC power, dividing it into two routes, and outputting them into said assistant power circuit 235 and said DC-DC transformer 208 respectively, a DC-DC transformer for stepping down the voltage which is inputted the DC-DC transformer and transforming it into the output voltage V_o, a DC-AC transformer 210 for electric connecting with said MCU 100 and inverting DC power to AC power .

The detection units each comprise some specifically resistant and operational amplifiers, which is set nearby the PFC 204, the DC-DC transformer 208 and the HID lamp 20, and electric connects with said MCU 100 for detecting working status, such as said PFC 204's output voltage V_s, said DC-DC transformer 208's output voltage V_o, the HID lamp20's temperature T or the practical load current I_o as the outer parameters of said MCU 100.

The MCU 100 directly uses said outer working voltage and generates a predefined load current I_p according to outer parameters such as the HID lamp's practical load current I_o. Moreover, the MCU 100 can further judge whether every received or fetched outer parameter is in a predefined range set in the MCU to determine whether to generate information (e.g. alarm information) that can be distinguished by user or whether to start control circuit. Further more, a UI may be set in said ballast device 1 for predefining said outer parameters (e.g. the HID lamp's 20 predefined load current I_p) by a user or the MCU 100. In a preferred embodiment of the present invention, the MCU 100 may choose ANALOG's ADUC812.

The PWM 220 has a PID control module 225 which can calculate said load

current I_p, the HID lamp's 20 practical load current I_o and an error value between above said two currents and can make said DC-DC transformer 208 properly adjust its output voltage V_o, then adjust the HID lamp's practical load current I_o steadily in a real-time manner.

Therefore, an active ballasting device1 according to the present invention embodies a power supply 10, which can directly supply the working power the ballast device needed, so it can save a working power circuit module that the existing technique requires. Secondly, the ballast device1 according to the present invention has a MCU 100, so that it can predefine the HID lamp's 20 predefined load start-up current I_p by a program, and at the same time it can detect the HID lamp's practical load current, and then the PID control module 225 calculates said current, so as to effect real-time and active control of the HID lamp 20's practical load start-up current I_o.

Referring to Fig.2, the active ballasting method for steadily controlling the control circuit between the control ballast 10 and a load module (e.g. the HID lamp 20) according to the present invention comprises the following steps:

Firstly, activating the power switch to make the power supply unit 10 receive an electrical source 200, and filtering (comprising bridge rectification) EMI by an EMI filter 202. Secondly, transforming AC voltage to DC voltage by a PFC and supplying the DC voltage through two output routes , wherein one of them acts as an input voltage of the assistant power circuit 235, and another is inputted into the DC-DC transformer and be stepped down as the output voltage V_o. The voltage that is inputted into the assistant power circuit 235 will be separated into two routes to output, and they are the assistant power V_{dd} and V_{cc}, V_{cc} acting as the assistant power's main output namely power supply, and V_{dd} acting as the working power of other elements, such as the MCU 10. Further, the DC-AC transformer 210 converts said output DC

voltage V_o to AC whose frequency is 400Hz acting as the HID 20's practical load voltage.

After the power is activated, the PID control module 225 calculates the output predefined load current I_p of the MCU 100 and the HID lamp 20's practical load current I_o that detected by said detection module. The DC-DC transformer 208 properly adjusts the output voltage V_o according to the result, thereby adjusts the HID lamp 20's practical load current I_o, in accordance with the practical load current Io, the MCU 100 can trace the predefined load current I_p in a real-time manner, and in this way the intent of limiting the start-up current is achieved.

The detailed working flow about said MCU 100 can further refer to Fig.3, and comprises:

Process S300 and S302, when the whole system is initializing, the MCU 100 tests itself;

Process S304, judging said test pass or not, and if not generating a flag in a buffer storage and giving a warning message to notice user;

Process S310, activating the PFC 204 to output voltage V_s;

Process S312, judging whether the PFC 204 has output voltage, that is to say judging whether the PFC 204 is in working order; if not, the MCU 100 sends an error message and ends the whole working flow;

Process S316, the MCU 100 outputs an inverted waveform to control the DC-AC transformer 210 to transform Vo into AC voltage and supply to the HID lamp 20;

Process S318, judging whether the HID lamp 20's practical load current I_o has been detected, that is to say judging whether the HID lamp 20 is in working order, if not, the MCU 100 sends an error message and ends the whole working flow;

Process S322, according to the detected HID lamp 20's practical load current I_o,

the MCU 100 outputs the predefined load current I_p;

Process S324, fetching various outer parameters which the detection module has detected, such as activating the PFC 204 for outputting the voltage V_s, the DC-DC transformer's outputting voltage V_o, the HID lamp's temperature T and the practical load current I_o; and

Process S326, judging whether said outer parameters are in the predefined range; if not, in process S328, the MCU 100 sends an error message and ends the whole working flow;

Referring to Fig. 4, it is a flow chart of a ballast device steadily controlling a HID lamp's practical load current according to the present invention's preferred embodiment, the process comprising:

Process S400, S402 and S405, using the PID control module to calculate with said MCU 100's output predefined load current I_p and the HID lamp 20's practical load current I_o;

Process S410, making the DC-DC transformer 208 properly adjust its output voltage V_o according to said calculate result;

Process S415, because the adjustment of output voltage V_o, we can adjust the load module's practical load active current in a real time manner; and

Process S415, detecting the practical load current I_o of the HID lamp 20 again, and outputting the predefined load current I_p according to the detected practical load current by the MCU 100, such in cycles, till achieving the aim of steadily controlling the active current I_o. Referring to Fig.5, fig.5 is an active characteristic graph of a HID lamp according to the present invention's preferred embodiment. It can be found that: at the beginning of the HID lamp 20's startup, the HID lamp 20's practical load active current is 150% or so of the normal current, conversely the voltage and power are only 20%-40% of the normal value. But after the HID lamp 20's current is steadily

controlled, the practical load current will gradually decline, however the voltage and power will gradually rise. It needs 1.5 min or so, the voltage and power arrive the normal value and stop rising. In this way, the present invention can protect the HID lamp 20 and the circuits in the ballast device efficiently.

From above it is to be understood, the ballast device according to the present invention controls all power circuits with the MCU 100; comprising:

1.Outputting an invert waveform, namely inverting DC power to AC power by the DC-AC transformer 210.

2.Fetching the HID lamp 20's practical load current Io, the detection module collects the output current Io's voltage and inputs it to the MCU 100.

3.Fetching the DC-DC transformer 208's output voltage Vo, which is collected and inputted to the MCU 100 by the detection module.

4.Fetching the PFC 204's output voltage Vs, which is collected and inputted to the MCU 100 by the detection module.

5.Controlling the HID lamp's load startup current steadily. Because the MCU 100 has a D/A CONV, we can predefine load startup current and make the practical load current and predefined load current voltage equal by the PID control module's character, so we can change output voltage by the DC-DC transformer 208 to achieve the intent of changing output current.

Sum up of the above, the ballast device having active ballasting circuit and the method of the present invention have a power supply unit directly supplies the working power that the ballast needed, so it can simplify the whole system and saves cost. Secondly, the present invention uses a MCU to fetch various working status as its outer parameters for active ballasting, so it can control a HID lamp start-up process steadily and real-timely.

It is to be understood, however, that even though numerous characteristics and

advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.